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Independent director network, agency costs and stock price crash risk

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ABSTRACT

It is of great significance to improve the corporate governance structure to study whether independent directors play the role of 'vase' in the governance of listed companies. Based on the social network theory, this article constructs the social network formed by interlocking independent directors and examines the influence of independent director network on stock price crash risk. The mechanism test analyses the mediating effect of principal–agent problem and large shareholder's tunnelling on stock price crash risk. The empirical research shows that the higher the network centrality of the company's independent directors, the lower the stock price crash risk. The independent director network can restrain the company's stock price crash risk by reducing two types of agency costs. Further research finds that the influence of independent director network on stock price crash risk is more pronounced in companies with unreasonable ownership structure, poor internal governance and weak external supervision. The research conclusions have important implications for listed companies to reduce the risk of stock price crash and maintain the stability of the capital market.

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1. Introduction

Finance is the blood of real economy, and the capital market is an important hub to promote the high-level development of the real economy. The capital market plays an important role in the financial system, and the listed companies are the cornerstone of the capital market. With the establishment of the science and technology innovation board and the steady progress of the registration system reform, the number of listed companies has grown rapidly. Taking China as an example, there were more than 4,000 companies by the end of 2020, and more than 1,000 companies were in the state of registration. However, in recent years, the phenomenon of 'surge and crash' in the stock price of the listed companies is not uncommon. In particular, the stock price crash caused by the 'slump' seriously damaged the interests of investors and weakened the functions of the capital market in reducing macro leverage and

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resource allocation (Wang et al., 2022). Therefore, investigating how to reduce the crash risk of stock price has become hot research topics in practice.

As the ‘gatekeeper’ of small and medium investors, independent directors are the important part of the governance system of the listed companies. The introduction of the independent director system is to alleviate the company’s principal–agent problem and to protect the interests of investors. But whether it can really play the role in the corporate governance has always been controversial. In 2019, China Kangmei pharmaceutical’s stock price plummeted due to financial fraud, and the independent director was sentenced to a huge amount of joint liability for the absence of supervision. The media and the public generally believe that independent directors are ‘not independent’ and only play the ‘vase’ role in the corporate governance. Although a large number of studies have shown that independent directors have supervisory and advisory functions, there are still scholars who believe that independent directors have not played their due role in the corporate governance (Wu & Dong, 2021). Nguyen and Nielsen (2010) believe that the reason for the above problems is that the independent directors’ characteristic variables commonly used in previous studies cannot accurately distinguish the roles of independent directors in the corporate governance. However, studying the governance behaviour of independent directors from the perspective of social network can effectively solve this issue. According to the relevant regulations of the association of the listed companies, one person may concurrently serve as independent directors of five listed companies at most. With the common existence of independent directors concurrently, the network of independent directors has been formed among the listed companies, which generates significant impact on the governance behaviour of independent directors in the company.

Fracassi and Tate (2012) and Berkman et al. (2020) examined the directors’ governance behaviours in companies from the perspective of social networks, and verified the influence of director networks on management oversight. Further, Shaw et al. (2016) found that the existence of director networks can improve the firm performance. Specifically, independent directors can obtain more social resources through the director network, so as to better play the supervisory role and to reduce agency costs. Liao and Chen (2021) found that the existence of independent director networks can improve the supervision ability and the motivation of independent directors, thereby improving the internal control of enterprises and enhancing the sustainability of profitability. Guo and Lv (2018) studied the influence of independent directors on cross-border M&A from the perspective of social networks, and found that the independent directors at the centre of the network can more effectively supervise cross-border M&A decisions and provide key information, resources and experience. It can be seen that the social capital in the social network brings about certain promotion effect on the supervision function of the independent directors, which can more effectively restrain the self-interested behaviour of manager and the tunnelling behaviour of major shareholders (Gong et al., 2021), hence reducing the two class agency costs. Seen from the existing research literature on stock price crash risk, agency cost acts as one of the drivers of stock price crash risk. Managers will deliberately hide the negative news of the company out of their own interests, causing the company’s stock price to be seriously overstated by the market. Eventually, when the negative news accumulates to certain degree where managers could no longer hide it, the bubble may burst and the stock price crashes. Hence, this article argues that the network of independent directors may act on the stock price crash risk by affecting the agency cost of the company.

This article puts forward and examines the following questions. What is the relationship among independent director social network, agency costs and stock price crash risk? Will this relationship be affected by other macro and micro governance factors, such as ownership structure, internal governance, and external oversight? Under different ownership structures of 'less tunnelling effect' and 'more tunnelling effect', what is the effect of independent director network characteristics on the heterogeneity of stock price crash risk? For companies with different internal governance efficiencies, what is the heterogeneous impact of independent director network characteristics on stock price crash risk? And how will the external oversight environment of analysts and research reports influence it?

The main contributions of this article mainly include the following aspects. Primarily, different with previous studies that mostly analysed the impact of independent directors' personal attributes on stock price crash risk, this article innovatively studies the impact of independent directors' social networks on stock price crash risk from the perspective of social resources. It not only enriches the relevant research on stock price crash risk, but also provides new evidence for how the independent directors play the role in the corporate governance. Secondly, we comprehensively studied independent directors' social capital, agency costs and stock price crash risk into the unified framework. Therefore, this article will clarify the relationship among independent directors' social networks, agency cost and stock price crash risk, and explore the mediating effect of principal–agent problem and major shareholder tunnelling behaviour in the process of independent director network affecting stock price crash risk. The research conclusions will provide decision-making reference for improving the corporate governance and restraining the crash risk of stock price.

2. Literature review and research hypothesis

2.1. Social networks of independent directors

Before 2001, the Chinese listed companies could decide whether to hire external independent directors at their own discretion. Most listed companies lacked effective supervision mechanism due to imperfect internal control system and governance structure. In order to further promote the standardised operation of the listed companies, the China Securities Regulatory Commission issued the 'Guiding Instruction' based on the experience of other countries, and began to require the listed companies to establish an independent director system. It instructs that the members of the director board of the listed companies should include at least 1/3 of independent directors. The introduction of independent director system aims to improve the governance structure of the listed companies, and restrains major shareholders so as to protect the interests of investors. Most of the existing studies start from the background of independent directors (Jin et al., 2022; Pang et al., 2020; Zhang & Truong, 2019), director independence (Nguyen & Nielsen, 2010), gender (Ararat & Yurtoglu, 2021) and other personal attributes to examine the influence of independent director on the stock price of listed companies. However, with the stricter corporate governance, various variables (especially independent directors' characteristic variables) in the previous corporate governance researches have gradually converged, which cannot well capture the differences in the internal governance of different companies. It is difficult to obtain unified answer based on researches on the personal attributes of independent directors (Nguyen & Nielsen, 2010). In addition, the governance behaviour of independent directors is also affected by various social network and social resources. As a consequence, rather than directly analysing the impact of independent directors on the company's stock price crash risk, it is more meaningful to examine the independent director social network and stock price crash risk.

There are many types of network relationships among the independent directors, such as the fellowship relationship, employment relationship, and kinship relationship. The network of independent directors defined in this article is the collection of connections established between independent directors due to serving on the same board (Liao & Chen, 2021). The reason why the independent directors are selected for analysis is that they have more obvious social network characteristics than the non-independent directors, who are generally full-time directors with fewer external concurrent positions. On the other hand, non-independent directors are mostly internal directors, and most of them will participate in the daily operation and management of the company. As external directors, independent directors are generally partners of law firms, partners of accounting firms, university professors, etc. They mainly participate in the corporate governance through the director board and various special committees, which have weak relationship with other members of the director board. According to the weak tie advantage theory, weak ties can transmit non-repetitive high-quality information between different groups, and play more important role in social structure than strong ties. As a result, this article proposes that the social network formed by concurrently serving as independent directors generates greater impact on the corporate governance.

2.2. Social networks of independent directors and stock price crash risk

As the most important measure in social network, network centrality is mainly employed to measure the degree to which the particular nodes in social network are located in the network centre so as to quantify its importance (Jackson et al., 2017). According to the social network theory, independent directors at the network centre have more social resources and wider information access channels, which in turn affects their roles in the corporate governance. The more the independent directors are in the centre of network, the more obvious their governance effect will be. Specifically, independent directors with more network ties are more likely to obtain social resources about the corporate governance, and obtain higher reputation in the field. Meanwhile, when the listed company encounters governance crisis due to lack of oversight, the independent directors with important network positions will face accusations from investors and penalties from regulators, and their reputation will be damaged more than other independent directors (Liao & Chen, 2021). In this case, the independent directors at network centre will be more motivated to monitor the self-interested behaviour of manager and the tunnelling behaviour of major shareholders. Moreover, independent directors with more social capital are more likely to regain their seats in other companies, and will not be afraid to supervise and restrain management. In this way, such independent directors have stronger 'bargaining' power in participating in the corporate governance, and are more likely to express objective and independent opinions, thereby enhancing the effect of their supervision (Sila et al., 2017). Therefore, independent directors at the core of the network have stronger motivation and ability to supervise the self-interested behaviour of manager and the tunnelling behaviour of major shareholders (Masulis & Mobbs, 2014), thus reducing agency costs.

Independent directors need to possess certain expertise in order to participate in the corporate governance effectively. The more important position in the social networks of independent directors, the more they can directly or indirectly connect with others, and the social resources they get will help them gain more experience (Liao & Chen, 2021). Hence, compared with the independent directors at the edge of the network, the independent directors with network importance are more likely to identify various agency problems, and are more likely to reduce the speculative behaviour of manager and the tunnelling behaviour of major shareholders, thereby inhibiting the stock price crash risk. To sum up, the higher the network centrality of independent directors, the better capability to restrain the company's stock price crash risk. Based on the above analysis, this article proposes the hypothesis H1:

> H1: The higher the network centrality of company's independent director, the lower the crash risk of stock price.

2.3. Social networks of independent directors, agency costs and stock price crash risk

The highly dispersed ownership structure makes the shareholders lack the motivation to supervise the management, and it is difficult to prevent the speculative behaviours of the management from seeking personal interests, resulting in the conflict of interests between the shareholders and the management. This conflict has become the main contradiction in corporate governance, forming the principal–agent problem (Kang & Liu, 2010), which we call the first class agency problem. In the capital market with insufficient legal protection for investors, ownership concentration makes major shareholders more motivated to encroach on the interests of small and medium shareholders, that is, 'large shareholder tunnelling behaviour' (Jiang et al., 2010, 2015), which we call the second category agency problem. Among the listed companies represented by China, the above two types of agency problems are common and produce significant impact on the company's stock price crash risk. Jin and Myers (2006) studied the causes of stock price crash risk from the perspective of agency problem. Due to self-interest such as option incentives (Kim et al., 2011b), on-the-job consumption (Xu et al., 2014) and business empire building (Cao et al., 2019; Li & Guo, 2021), managers will deliberately hide the negative news of the company, which makes the stock price of the company seriously overvalued by the market. Eventually, when the negative news accumulates to a point where managers can no longer hide it, the bubble bursts and the stock price crashes. In addition, Sun et al. (2017) and Yang et al. (2021) found that the agency problem between large shareholders and small shareholders caused by the 'tunnelling' behaviour of large shareholders will also affect the company's stock price crash risk. When the major shareholders carry out the hollowing behaviour and hide negative news, it will increase the crash risk of stock price.

The management often deliberately hides the negative news of the company out of personal interests, such as option incentives, building a business empire, and on-the-job consumption, which increases the crash risk of listed company's stock price. While oversight mechanisms inside and outside the company will increase the cost of the management to hide bad news. Depending on the constraints it faces, management decides whether to hide bad news to maximise its own interests. As an important governance system within the company, the independent director system can more effectively reduce the behaviour of the management to seek personal interests and to hide bad news. In particular, independent directors at the centre of social networks have stronger supervisory ability and motivation, thereby reducing the accumulation of bad news within the company and suppressing the risk of stock price crash. Based on the above analysis, this article proposes the hypothesis H2:

H2: Principal–agent costs play intermediary roles in independent director social networks affecting stock price crash risk.

For the agency problem between the large shareholders and the small shareholders. In the Chinese market, most managers of listed companies are directly appointed by the major shareholders. Large shareholders strengthen their control over listed companies through management, and thus have a strong incentive to encroach on the interests of small shareholders through capital occupation, related transactions, internal loans and other means. In order to cover up the bad performance impact of the 'tunnelling' behaviour on the company, major shareholders will hide the corresponding negative information. It leads to the accumulation of bad news within the company and the increase on crash risk of stock price. For different companies, the degree of difficulty for major shareholders to carry out 'tunnelling' behaviour and to hide related bad news varies, which largely depends on the supervision effectiveness of the company's independent directors. One of the important responsibilities of independent directors to safeguard the interests of small shareholders is to prevent large shareholders from 'tunnelling' the company. The more central the independent directors are in the social network, the stronger their oversight ability and motivation, and the more difficult it is for major shareholders to carry out 'tunnelling' behaviour. It decreases the accumulation of bad news within the company and reduces the crash risk of company's stock price. Based on the above analysis, this article proposes the hypothesis H3:

H3: The agency costs formed by the tunnelling behaviour of major shareholders play intermediary roles in independent director social networks affecting stock price crash risk.

3. Research design

3.1. Independent director network topology indicators

In order to measure the relationship between individuals in social networks, according to Kuang and Lee (2017), three centrality indicators including degree, betweenness and closeness centrality are used to measure the importance of independent directors in the social networks. At the same time, in order to measure the network centrality of independent directors at the company level more comprehensively, the comprehensive network centrality indicator is calculated after eliminating the dimensional differences (Larcker et al., 2010) as follows.

Primarily, according to the concurrent positions of the independent directors of the listed companies, three network centrality indicators of each independent director are calculated. Then, for each listed company, the arithmetic mean of all independent directors' network centrality indicators is calculated to obtain the firm-level network centrality index. Finally, in order to eliminate the difference in the dimensions of degree centrality, betweenness centrality and closeness centrality indicators, the obtained firm-level network centrality indicators are divided into ten groups from small to large with assigned values from 0 to 9. And we calculate the arithmetic average of the three indicators to obtain the comprehensive independent director network centrality (*CENMEAN*). Similarly, taking the maximum value when calculating the three network centrality indicators at the firm level, the comprehensive company independent director network centrality (*CENMAX*) can also be obtained.

Degree centrality can measure the number of connections between independent directors and others in the social network, reflecting the independent director's ability to obtain social capital in the social network. The greater the network degree centrality of independent directors, the more important they are in the network.

$$Degree_i = \frac{\sum_j X_{ji}}{g-1} \tag{1}$$

where j represents the independent director, and i represents other independent directors; when director i and director j serve on the same board, $X_{j,i}$ takes the value of 1, otherwise 0. g denotes the total number of independent directors, and uses g-1 to eliminate the scale effect.

Betweenness centrality measures the degree of control that the independent director has over the connections between other directors in the network, that is, the number of times the independent director acts as an intermediary between any two other directors with the shortest connection route. The greater the betweenness centrality, the more important the role of independent directors in the network.

$$Betweenness_i = \frac{\sum_{j<k} g_{jk(n_i)}/g_{jk}}{(g-1)(g-2)} \tag{2}$$

where g_{jk} represents the number of shortest connection paths between independent directors j and k, and $g_{jk(ni)}$ represents the number of paths in which director

i acts as medium among the shortest connection paths of independent directors j and k.

Closeness centrality is employed to measure the distance between independent director and others in the network, which reflects the proximity between independent directors and other network members. The greater the closeness centrality, the closer the independent directors are to other members in the network, and the more network importance they have.

$$Closeness_i = \left[\sum_{j=1}^{g} d(i,j)/g - 1\right]^{-1} \tag{3}$$

where $d(i,j)$ represents the distance from director i to director j. g denotes the number of directors, and g-1 is used to eliminate scale differences.

3.2. Stock price crash risk

Following the stock price crash risk model of Kim et al. (2011a, 2011b), this article employs the negative returns skewness coefficient (*NCSKEW*) and the stock return volatility ratio (*DUVOL*) to measure the stock price crash risk. Firstly, the following regression using the weekly return data of stock i by year is performed.

$$r_{i,t} = \alpha_i + \beta_1 r_{m,t-2} + \beta_2 r_{m,t-1} + \beta_3 r_{m,t} + \beta_4 r_{m,t+1} + \beta_5 r_{m,t+2} + \varepsilon_{i,t} \tag{4}$$

where $r_{m,t}$ is the average returns of all stocks weighted by the market value in week t; and $r_{i,t}$ is the returns of stock i considering the reinvestment of cash dividends in week t. At the same time, the market returns of two periods ahead and two periods behind are added to Equation (4) to reduce the possible bias caused by transaction asynchrony.

The residual value $\varepsilon_{i,t}$ can be obtained using Equation (4), and then the company-specific returns $w_{i,t}=ln(1+\varepsilon_{i,t})$ of stock i in week t can be calculated. Then, the negative returns skewness coefficient and the stock returns volatility ratio are calculated, which can be expressed as follows.

$$NCSKEW_{i,t} = \frac{(-n)(n-1)^{\frac{3}{2}}\sum w_{i,t}^3}{(n-2)(n-1)\left(\sum w_{i,t}^2\right)^{\frac{3}{2}}} \tag{5}$$

where n is the number of trading weeks for stock i per year. The higher the *NCSKEW* value, the higher the crash risk of stock price.

$$DUVOL_{i,t} = \log \frac{(n_u - 1)\sum_{down} w_{i,t}^2}{(n_d - 1)\sum_{up} w_{i,t}^2} \tag{6}$$

All the weeks of stock i in certain year are divided into two categories according to whether the weekly unique returns $w_{i,t}$ is higher than the average weekly unique returns of the year. That is, it is divided into two types: weeks ('up weeks') that is higher than the average weekly returns of the whole year and weeks ('down weeks') that are lower than the average weekly returns of the year. In Equation (6), $n_u(n_d)$ is the number of weeks in which the weekly returns $w_{i,t}$ of stock i is greater than (less than) the annual average returns. The higher the *DUVOL* value, the higher the crash risk of stock price.

3.3. Agency cost

The agency problem involved in this article includes both the first type of agency problem between the shareholders and the management, and the second type of agency problem between large shareholders and small shareholders. Following Ang et al. (2000), the management expense ratio (the ratio of management expenses to operating income in year *t*) is employed to measure the first type of agency cost (AC_1). The higher the overhead rate, the higher the cost of the first type of agency. Following Jiang et al. (2010), the second type of agency cost (AC_2) is measured by the capital occupation of large shareholders (the proportion of other receivables of the company in the total assets at the end of year *t*). The larger the proportion of other receivables, the more serious the behaviour of large shareholders encroaching on the interests of small shareholders.

4. Model specification

To test the hypothesis 1, this article constructs the following model in Equation (7). Following the existing researches on stock price crash risk (Cao et al., 2022; Luo & Zhang, 2020), the control variables in the model include the following: (1) the negative returns skew coefficient (*NCSKEW*) in year *t*; (2) the average weekly returns (*RET*), which is the average of the unique weekly returns in year *t*; (3) the returns volatility (*SIGMA*) is the standard deviation of the weekly unique returns in year *t*; (4) average monthly excess turnover ratio (*TURNOVER*) is the difference between the average monthly turnover rate of stocks in year *t* and the average monthly turnover rate of the previous year; (5) the management shareholding ratio (*EXEHOLD*), which is the number of shares held by executives in year *t* divided by the total share capital of the company in year *t*; (6) returns on total assets (*ROA*), which is the net profit in year *t* divided by total assets at the end of year *t*; (7) asset–liability ratio (*LEV*), which is the liabilities divided by total assets at the end of year *t*; (8) market-to-book ratio (M.B.), which is the total market value of the company at the end of year *t* divided by the company's shareholders' equity; (9) the scale of the company (*SIZE*), which is the natural logarithm of the company's market value at the end of year *t*; (10) the scale of director board (*BOARD*), which is the number of board members; (11) the proportion of independent directors (*OUT*), which is the ratio of independent directors to the total number of directors; (12) *DUALITY*, if the chairman and the general manager are the same person, the value is 1, otherwise 0. In addition, year and industry effects are also controlled. According to the hypothesis 1, the coefficient β_1 of *CENMEAN* in model (7) should be significantly negative.

$$CRASH_{i,t+1} = \alpha + \beta_1 \times CENMEAN_{i,t}(CENMAX_{i,t}) + \gamma_1 \times \sum Controls_{i,t} + Year + Ind + \varepsilon_{i,t+1} \quad (7)$$

where *CRASH* represents the stock price crash risk of company i in year $t+1$, which is measured by the negative returns skewness coefficient (*NCSKEW*) and the stock returns volatility ratio (*DUVOL*), respectively. And *CENMEAN* and *CENMAX* represent the independent director network centrality of company i in year t calculated using different methods, respectively, and *Controls* denotes the control variable.

To test the hypotheses 2 and 3, the following model is constructed using the mediation test procedure.

$$AC_{i,t} = \alpha + \beta_2 \times CENMEAN_{i,t}(CENMAX_{i,t}) + \gamma_2 \times \sum Controls_{i,t} + Year + Ind + \varepsilon_{i,t} \quad (8)$$

where *Controls* include asset–liability ratio (*LEV*), fixed asset ratio (*TANGIBLE*), management shareholding ratio (*EXEHOLD*), duality (*DUALITY*), proportion of independent directors (*OUT*), equity balance degree (*BALANCE*), and listing period (LISTAGE).

$$CRASH_{i,t+1} = \alpha + \beta_{31} \times CENMEAN_{i,t}(CENMAX_{i,t}) + \beta_{32} \times AC_{1,t} + \beta_{33} \times AC_{2,t} + \gamma_3 \times \sum Controls_{i,t} + Year + Ind + \varepsilon_{i,t+1} \quad (9)$$

Models (7)–(9) are adopted to examine the mediating effect of agency costs for the impact of independent directors' network centrality on stock price crash risk. In model 7, the coefficient β_1 represents the total effect of *CENMEAN*(*CENMAX*) on *CRASH*. In model 8, the coefficient β_2 represents the effect of *CENMEAN*(*CENMAX*) on *AC*. In model 9, the coefficients β_{32} and β_{33} represent the effect of *AC* on *CRASH*, and β_{31} is the direct effect of *CENMEAN*(*CENMAX*) on *CRASH* after *AC* is controlled. The mediating effect can be described in the schematic diagram shown in Figure 1.

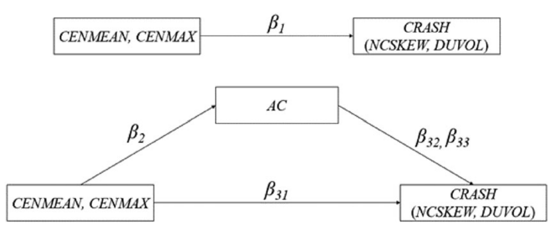

Figure 1. Schematic diagram of the mediating effect.
Source: The authors.

5. Empirical analysis

5.1. Data and descriptive statistics

Based on the Chinese listed companies from 2010 to 2021, this article screened the sample data as follows: (1) exclude companies with missing values; (2) exclude ST companies; (3) exclude listed companies in the financial industry; and (4) exclude companies with less than 30 weekly returns observations per year so as to better calculate crash risk. Finally, a total of 16,656 sample data from 1388 listed companies were obtained. In addition, we winsorise all continuous variables at the 1% and 99% quantiles, with the data mainly from Wind and C.S.M.A.R. databases.

Table 1 displays the descriptive statistics of the variables. It can be found that the mean values of the negative returns skewness coefficient (N.C.S.K.E.W.) and the stock returns volatility ratio (D.U.V.O.L.) that measure the crash risk of stock price are −0.344 and −0.225, respectively. And from the perspective of the change trend covering the 25%∼75% quantile, the crash risk of stock price gradually increases. Under the 90% quantile, the corresponding values are 0.482 and 0.394, respectively, indicating that there exists common stock price crash risk in China's listed companies. Besides, the corresponding standard deviations are 0.760 and 0.498, respectively, indicating that there are large differences in the crash risk of different companies. The mean values of the company's independent directors' network centrality (CENMEAN and CENMAX) are 4.448 and 4.456, respectively. The descriptive statistical results of control variables are basically consistent with the relevant literature. Among them, the values of the 25% quantile, median and 75% quantile of the proportion of independent directors are 0.333, 0.333 and 0.400, respectively, indicating that the proportion of independent directors in the director board in most companies ranges from 30% to 40%.

5.2. Independent director networks and stock price crash risk

Table 2 shows the relationship between network centrality of independent directors and stock price crash risk. It can be seen that when employing the negative returns

Table 1. Descriptive statistics.

Variable	N	MEAN	SD	P25	P50	P75	P90
NCSKEW	13,622	−0.344	0.760	−0.748	−0.291	0.094	0.482
DUVOL	13,622	−0.225	0.498	−0.549	−0.219	0.095	0.394
CENMEAN	13,622	4.448	2.613	2.333	4.333	6.667	8.000
CENMAX	13,622	4.456	2.612	2.333	4.667	6.667	8.000
RET	13,622	0.002	0.009	−0.004	0.001	0.007	0.013
SIGMA	13,622	0.059	0.023	0.044	0.055	0.068	0.088
TURNOVER	13,622	−0.049	0.336	−0.197	−0.026	0.098	0.304
EXEHOLD	13,622	0.037	0.110	0.000	0.000	0.003	0.120
ROA	13,622	0.037	0.085	0.012	0.032	0.062	0.103
LEV	13,622	0.498	0.280	0.341	0.501	0.645	0.756
MB	13,622	2.428	20.620	1.194	1.622	2.455	3.860
SIZE	13,622	23.100	1.175	22.270	22.950	23.770	24.640
BOARD	13,622	8.938	1.814	8.000	9.000	9.000	11.000
OUT	13,622	0.372	0.057	0.333	0.333	0.400	0.429
DUALITY	13,622	0.176	0.381	0.000	0.000	0.000	1.000

Source: calculated by the authors.

Table 2. Independent directors' network centrality and stock price crash risk.

Variable	(1) $NCSKW_{t+1}$	(2) $DUVOL_{t+1}$	(3) $NCSKW_{t+1}$	(4) $DUVOL_{t+1}$
$CENMEAN_t$	−0.0069***	−0.0039**		
	(−2.74)	(−2.37)		
$CENMAX_t$			−0.0076***	−0.0040**
			(−3.02)	(−2.35)
$NCSKEW_t$	0.0891***	0.0601***	0.0892***	0.0602***
	(10.07)	(10.19)	(10.08)	(10.20)
RET_t	14.2911***	9.3489***	14.3084***	9.3607***
	(12.17)	(11.95)	(12.19)	(11.96)
$SIGMA_t$	−0.1012	−0.2836	−0.1035	−0.2856
	(−0.22)	(−0.92)	(−0.22)	(−0.93)
$TURNOVER_t$	−0.0562**	−0.0407**	−0.0559**	−0.0406**
	(−2.00)	(−2.18)	(−1.99)	(−2.17)
$EXEHOLD_t$	0.1018	0.0170	0.1024	0.0173
	(1.62)	(0.41)	(1.63)	(0.41)
ROA_t	0.2300*	0.1390	0.2282*	0.1374
	(1.79)	(1.62)	(1.77)	(1.60)
LEV_t	0.0457	0.0372	0.0452	0.0368
	(1.21)	(1.47)	(1.19)	(1.46)
MB_t	0.0009***	0.0005**	0.0009***	0.0005**
	(3.07)	(2.35)	(3.07)	(2.36)
$SIZE_t$	0.0064	−0.0033	0.0066	−0.0033
	(0.93)	(−0.72)	(0.95)	(−0.72)
$BOARD_t$	−0.0053	−0.0046*	−0.0048	−0.0044
	(−1.33)	(−1.73)	(−1.18)	(−1.64)
OUT_t	0.0277	0.0235	0.0459	0.0331
	(0.22)	(0.28)	(0.37)	(0.39)
DUALITYt	−0.0228	−0.0192*	−0.0228	−0.0193*
	(−1.39)	(−1.76)	(−1.39)	(−1.77)
Time	Y	Y	Y	Y
Industry	Y	Y	Y	Y
_cons	−0.4239***	−0.1049	−0.4365***	−0.1095
	(−2.66)	(−0.99)	(−2.74)	(−1.03)
N	13,622	13,622	13,622	13,622
R^2	0.0519	0.0531	0.0520	0.0531

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level and ***means significant at the 1% confidence level.
Source: calculated by the authors.

skewness coefficient (*NCSKEW*) to measure crash risk, the regression coefficients between the network centrality of independent directors and crash risk are both significantly negatively correlated at the 1% level. When employing the stock returns volatility ratio (*DUVOL*) to measure crash risk, the regression coefficients of independent directors' network centrality and stock price crash risk are significantly negatively correlated at 5% levels. This shows that the higher the network centrality of independent directors of listed companies, the lower the crash risk of stock price, which verifies the hypothesis 1.

Seen from the control variables, the stock price crash risk, average weekly returns, and market-to-book ratio in year t are significantly positively correlated with the stock price crash risk in year $t+1$, and the returns volatility is significantly negatively correlated with stock price crash risk. The conclusions found in this article are consistent with the existing research findings (Cao et al., 2022; Kim et al., 2011a, 2011b). There are no significant correlations between the director board scale and crash risk, as well as the relationship between the proportion of independent directors and crash

Table 3. Two types of agency costs and network centrality of independent directors.

	Principal–agent cost		Large shareholder's tunnelling behaviour	
Variable	AC_1	AC_1	AC_2	AC_2
CENMEAN	−0.0011***		−0.0002**	
	(−3.67)		(−2.10)	
CENMAX		−0.0010***		−0.0002**
		(−3.54)		(−2.48)
LEV	−0.0083*	−0.0082*	0.0215***	0.0215***
	(−1.80)	(−1.78)	(15.26)	(15.28)
TANGIBLE	−0.0241***	−0.0240***	−0.0204***	−0.0204***
	(−3.98)	(−3.98)	(−11.22)	(−11.22)
EXEHOLD	−0.0440***	−0.0439***	−0.0005	−0.0005
	(−4.05)	(−4.03)	(−0.16)	(−0.16)
DUALITY	0.0103***	0.0103***	0.0004	0.0004
	(5.40)	(5.40)	(0.72)	(0.72)
OUT	0.0230	0.0246*	0.0023	0.0026
	(1.56)	(1.68)	(0.51)	(0.58)
BALANCE	−0.0007	−0.0008	0.0015***	0.0015***
	(−0.44)	(−0.46)	(2.95)	(2.95)
LISTAGE	0.0071*	0.0071*	0.0025**	0.0025**
	(1.87)	(1.86)	(2.26)	(2.25)
Time	Y	Y	Y	Y
Industry	Y	Y	Y	Y
_cons	−0.9596***	−0.9603***	0.0107***	0.0106***
	(−81.78)	(−81.93)	(3.09)	(3.09)
N	15,835	15,835	15,829	15,829
R^2	0.9290	0.9290	0.1090	0.1092

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level and ***means significant at the 1% confidence level.
Source: Calculated by the authors.

risk. It indicates that the expansion of the board scale and the increase of the proportion of independent directors will not generate impact on stock price crash risk.

5.3. The mediating effect of agency costs

Tables 3 and 4 report the regression results for the hypotheses 2 and 3. As described above, the mediation effect test is used to determine whether the independent director network has an impact on stock price crash risk through two types of agency costs. The principal–agent cost and the tunnelling behaviour by large shareholders constitute the two types of agency cost in this article.

Firstly, the results in 5.2 presented a negative and significant correlation between the network centrality of independent directors and stock price crash risk. Secondly, Table 3 shows the relationship between the two types of agency costs and the importance of the independent director network. The results show that the coefficient of the principal–agent cost is significantly negative at the 1% confidence level, and the coefficient of the agency cost of the large shareholder's tunnelling behaviour is significantly negative at the 5% confidence level. The network centrality of independent directors has a significant negative effect on two types of agency costs. Finally, Table 4 examines the impact of two types of agency costs on the relationship between independent director network importance and stock price crash risk. It can be seen that whether *NCSKEW* or *DUVOL* is used as a measure of stock price crash risk, the coefficients of two kinds of principal–agent cost are significantly positive at the 1%

Table 4. Network centrality of independent directors, two types of agency costs and stock price crash risk.

Variable	(1) $NCSKW_{t+1}$	(2) $DUVOL_{t+1}$	(3) $NCSKW_{t+1}$	(4) $DUVOL_{t+1}$
$CENMEAN_t$	−0.0065***	−0.0037**		
	(−2.60)	(−2.25)		
$CENMAX_t$			−0.0073***	−0.0038**
			(−2.90)	(−2.25)
$AC_{1,t}$	0.2717***	0.1714***	0.2724***	0.1720***
	(3.71)	(3.51)	(3.72)	(3.52)
$AC_{2,t}$	0.7066***	0.4227***	0.7044***	0.4223***
	(3.04)	(2.73)	(3.03)	(2.72)
$NCSKEW_t$	0.0872***	0.0588***	0.0872***	0.0589***
	(9.84)	(9.97)	(9.85)	(9.98)
RET_t	14.2242***	9.3060***	14.2398***	9.3169***
	(12.12)	(11.90)	(12.14)	(11.91)
$SIGMA_t$	−0.2934	−0.4017	−0.2954	−0.4038
	(−0.64)	(−1.31)	(−0.64)	(−1.31)
$TURNOVER_t$	−0.0523*	−0.0379**	−0.0520*	−0.0378**
	(−1.86)	(−2.03)	(−1.85)	(−2.02)
$EXEHOLD_t$	0.1038*	0.0193	0.1043*	0.0196
	(1.66)	(0.46)	(1.66)	(0.47)
ROA_t	0.3238**	0.1986**	0.3224**	0.1973**
	(2.48)	(2.28)	(2.47)	(2.27)
LEV_t	0.0564	0.0447*	0.0560	0.0444*
	(1.46)	(1.73)	(1.45)	(1.72)
MB_t	0.0007**	0.0004*	0.0007**	0.0004*
	(2.45)	(1.78)	(2.45)	(1.78)
$SIZE_t$	0.0099	−0.0011	0.0101	−0.0011
	(1.43)	(−0.23)	(1.46)	(−0.23)
$BOARD_t$	−0.0054	−0.0047*	−0.0048	−0.0044*
	(−1.34)	(−1.74)	(−1.19)	(−1.65)
OUT_t	0.0086	0.0131	0.0260	0.0222
	(0.07)	(0.16)	(0.21)	(0.27)
$DUALITY_t$	−0.0256	−0.0209*	−0.0257	−0.0209*
	(−1.56)	(−1.91)	(−1.56)	(−1.92)
Time	Y	Y	Y	Y
Industry	Y	Y	Y	Y
_cons	−0.2485	0.0052	−0.2605	0.0011
	(−1.48)	(0.05)	(−1.55)	(0.01)
N	13,616	13,616	13,616	13,616
R^2	0.0536	0.0546	0.0537	0.0546

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level and ***means significant at the 1% confidence level.
Source: Calculated by the authors.

confidence level and the absolute value of the coefficient of the network centrality of independent directors in model 9 is smaller than that in model 7. The above results indicate that the two types of agency cost play an intermediary effect. After adding the mediating variable, the coefficient of the network centrality of independent directors is still significant, indicating that the two kinds of principal–agent cost play partial mediating roles.

5.4. Robustness test

The possible endogeneity problems between independent director network and the crash risk of stock price mainly include two aspects: one is the problem of two-way causality. Independent directors in the centre of network can reduce the crash risk of stock price, but there is also the possibility that the firm's shareholders or management have the will to reduce crash risk, so they are more willing to hire those who are in the centre of social network with abundant social resources. The second is the problem of missing variables. Companies are affected by firm characteristics in selecting independent directors, and these firm characteristics can also affect stock price crash risk, leading to the problem of missing variables.

In order to solve the causality problem that may exist between the explanatory variables and the explained variables, the explanatory variables and the control variables in models (7) and (9) are treated with one-period lag. For possible missing variables, the two-stage regression of proxy variables is used to further control the effect of endogeneity on the results. Following Usman et al. (2019), the independent director network centrality is regressed on corporate governance variables and corporate characteristic variables in the first-stage, in which corporate governance factors contain management's shareholding, company size, board size, independent director ratio, duality, and corporate characteristic factors contain returns on total assets, asset–liability ratio, market-to-book ratio, etc. Then, the regression residuals of the first stage are used as instrumental variables of network centrality of independent directors to conduct regression tests. The test results are shown in columns (1) to (4) of Table 5, which indicate that the network centrality of firm independent directors is still significantly negatively correlated with stock price crash risk.

Subsequently, the robustness tests are performed through changing the firm's independent director network centrality and changing the stock price crash risk. The results are shown in columns (5) and (6) of Table 5, where the independent director network centrality calculated using the median is still significantly negatively correlated with crash risk. The probability of stock slump (*Crash*) is further employed to measure the crash risk. If the weekly unique returns of stocks in a certain year satisfies Equation (10) at least once, the *Crash* value is 1, otherwise 0. And the corresponding regression results are shown in columns (7) and (8) of Table 5, which show that the network centrality is still significantly negatively correlated with crash risk.

$$w_{i,t} \leq Average(w_{i,t}) - 3.09\sigma_i^3 \tag{10}$$

where σ_i is the standard deviation of the weekly unique returns of stock i, and $Average(w_{i,t})$ denotes the annual average of the weekly unique returns of stock i.

In addition, the robustness tests are carried out by replacing the control variables, excluding special samples and changing parameter estimation methods. And the results still support the above conclusions.

6. Extended analysis

In order to more comprehensively investigate the internal mechanism of independent director network affecting stock price crash risk through agency cost, further tests are conducted from the perspectives of ownership structure, internal governance and external supervision.

Table 5. Endogeneity test and robustness test.

Variable	(1) $NCSKW_{t+1}$	(2) $DUVOL_{t+1}$	(3) $NCSKW_{t+1}$	(4) $DUVOL_{t+1}$	(5) $NCSKW_{t+1}$	(6) $DUVOL_{t+1}$	(7) *Crash*	(8) *Crash*
$CENMEAN_t$	−0.0068***	−0.0039**					−0.0022**	
	(−2.68)	(−2.32)					(−1.97)	
$CENMAX_t$			−0.0075***	−0.0039**				−0.0025**
			(−2.93)	(−2.26)				(−2.26)
$CENMEDIAN_t$					−0.0080***	−0.0045**		
					(−2.97)	(−2.48)		
$NCSKEW_t$	0.0749***	0.0483***	0.0749***	0.0484***	0.0892***	0.0601***	0.0036	0.0036
	(8.40)	(8.18)	(8.41)	(8.19)	(10.07)	(10.19)	(0.93)	(0.93)
RET_t	11.2378***	6.6423***	11.2739***	6.6608***	14.2354***	9.3190***	0.8785*	0.8835*
	(12.10)	(10.57)	(12.14)	(10.59)	(12.12)	(11.90)	(1.71)	(1.72)
$SIGMA_t$	−0.6663*	−0.4515*	−0.6632*	−0.4507*	−0.0952	−0.2805	−0.3907*	−0.3912*
	(−1.83)	(−1.85)	(−1.82)	(−1.85)	(−0.21)	(−0.91)	(−1.93)	(−1.94)
$TURNOVER_t$	−0.2255***	−0.1540***	−0.2249***	−0.1541***	−0.0558**	−0.0405**	−0.0096	−0.0095
	(−9.38)	(−9.50)	(−9.36)	(−9.50)	(−1.99)	(−2.17)	(−0.78)	(−0.77)
$EXEHOLD_t$	0.0886	0.0055	0.0893	0.0059	0.1022	0.0172	0.0409	0.0411
	(1.46)	(0.13)	(1.47)	(0.15)	(1.63)	(0.41)	(1.49)	(1.49)
ROA_t	0.2946**	0.1451*	0.2915**	0.1436*	0.2314*	0.1396	−0.0772	−0.0776
	(2.31)	(1.66)	(2.29)	(1.65)	(1.80)	(1.63)	(−1.37)	(−1.37)
LEV_t	0.0219	0.0070	0.0213	0.0067	0.0448	0.0367	0.0208	0.0207
	(0.60)	(0.29)	(0.59)	(0.27)	(1.18)	(1.45)	(1.25)	(1.24)
MB_t	0.0009***	0.0005**	0.0009***	0.0005**	0.0009***	0.0005**	0.0004***	0.0004***
	(3.36)	(2.11)	(3.36)	(2.11)	(3.09)	(2.37)	(3.23)	(3.23)
$SIZE_t$	0.0113*	0.0044	0.0115*	0.0043	0.0070	−0.0030	−0.0091***	−0.0091***
	(1.83)	(1.04)	(1.86)	(1.03)	(1.01)	(−0.65)	(−3.02)	(−2.99)
$BOARD_t$	−0.0078**	−0.0069***	−0.0072*	−0.0067**	−0.0050	−0.0045*	−0.0008	−0.0006
	(−1.97)	(−2.64)	(−1.82)	(−2.54)	(−1.25)	(−1.67)	(−0.48)	(−0.36)
OUT_t	−0.0496	−0.0365	−0.0318	−0.0269	0.0327	0.0263	0.0105	0.0164
	(−0.39)	(−0.44)	(−0.25)	(−0.32)	(0.26)	(0.31)	(0.19)	(0.30)
DUALITYt	−0.0178	−0.0157	−0.0178	−0.0158	−0.0226	−0.0191*	−0.0033	−0.0033
	(−1.06)	(−1.41)	(−1.06)	(−1.42)	(−1.38)	(−1.75)	(−0.46)	(−0.46)
Time	Y	Y	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y	Y	Y
_cons	−0.4817***	−0.2194**	−0.4946***	−0.2236**	−0.4391***	−0.1127	0.3447***	0.3401***
	(−3.42)	(−2.31)	(−3.51)	(−2.35)	(−2.75)	(−1.06)	(4.94)	(4.86)
N	13,622	13,622	13,622	13,622	13,622	13,622	13,622	13,622
R^2	0.0220	0.0188	0.0222	0.0188	0.0520	0.0532	0.0098	0.0099

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level and ***means significant at the 1% confidence level.
Source: Calculated by the authors.

6.1. Shareholding structure effect

The motivation of large shareholders to tunnel the company is related to their shareholding ratio. The relationship between shareholding ratio of large shareholders and the tunnelling behaviour is not simply linear. On the one hand, the higher the shareholding ratio of shareholders, the greater the speaking right. The increase in shareholding ratio makes it easier for large shareholders to control the firm, and it is easy to increase the tunnelling of the company. On the other hand, as the shareholding ratio of large shareholders increases, more company's wealth attributes to large shareholders, and less interest gains through tunnelling. When the shareholding ratio increases to a certain extent, the unfavourable consequences caused by the large shareholders tunnelling will also cause them to incur huge losses, and the large shareholders' willingness to tunnel will decrease accordingly. Therefore, when the shareholding ratio of large shareholders is low or high, there is less tunnelling effect, and vice versa, the tunnelling effect will be greater. Following Jiang et al. (2018), the

Table 6. Shareholding structure effect: shareholding ratio of the largest shareholder.

	Less tunnelling effect				More tunnelling effect			
Variable	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$
$CENMEAN_t$	−0.0026	−0.0023			−0.0104***	−0.0051**		
	(−0.74)	(−0.97)			(−2.98)	(−2.18)		
$CENMAX_t$			−0.0028	−0.0017			−0.0118***	−0.0056**
			(−0.78)	(−0.73)			(−3.32)	(−2.38)
$NCSKEW_t$	0.1043***	0.0659***	0.1043***	0.0659***	0.0702***	0.0515***	0.0704***	0.0516***
	(8.23)	(7.85)	(8.23)	(7.86)	(5.66)	(6.19)	(5.67)	(6.20)
RET_t	13.6319***	8.8738***	13.6443***	8.8832***	13.5023***	8.7657***	13.5125***	8.7718***
	(7.99)	(7.85)	(7.99)	(7.86)	(8.22)	(7.96)	(8.23)	(7.97)
$SIGMA_t$	−0.8132	−0.6949	−0.8150	−0.6976	0.4623	0.0283	0.4608	0.0274
	(−1.24)	(−1.60)	(−1.24)	(−1.60)	(0.71)	(0.07)	(0.71)	(0.06)
$TURNOVER_t$	−0.0522	−0.0392	−0.0521	−0.0392	−0.0531	−0.0382	−0.0525	−0.0379
	(−1.34)	(−1.52)	(−1.34)	(−1.52)	(−1.31)	(−1.40)	(−1.29)	(−1.39)
$EXEHOLD_t$	0.1011	0.0240	0.1013	0.0241	0.1054	0.0072	0.1064	0.0077
	(1.08)	(0.39)	(1.09)	(0.39)	(1.24)	(0.13)	(1.25)	(0.14)
ROA_t	0.2701	0.1839	0.2697	0.1826	0.1252	0.0528	0.1212	0.0507
	(1.50)	(1.54)	(1.50)	(1.53)	(0.68)	(0.42)	(0.65)	(0.41)
LEV_t	0.0669	0.0669*	0.0667	0.0665*	0.0231	0.0106	0.0220	0.0100
	(1.22)	(1.84)	(1.22)	(1.83)	(0.44)	(0.30)	(0.42)	(0.28)
MB_t	0.0170***	0.0119***	0.0170***	0.0119***	0.0008***	0.0004*	0.0008***	0.0004*
	(5.20)	(5.52)	(5.19)	(5.52)	(2.61)	(1.81)	(2.62)	(1.82)
$SIZE_t$	0.0136	0.0023	0.0136	0.0021	0.0060	−0.0040	0.0065	−0.0038
	(1.39)	(0.35)	(1.39)	(0.33)	(0.61)	(−0.60)	(0.65)	(−0.57)
$BOARD_t$	−0.0101*	−0.0064*	−0.0099*	−0.0064*	−0.0003	−0.0028	0.0006	−0.0024
	(−1.81)	(−1.73)	(−1.77)	(−1.72)	(−0.06)	(−0.73)	(0.11)	(−0.61)
OUT_t	−0.1759	−0.1675	−0.1685	−0.1624	0.1893	0.1838	0.2152	0.1961
	(−0.99)	(−1.43)	(−0.95)	(−1.38)	(1.05)	(1.53)	(1.20)	(1.63)
DUALITYt	−0.0418*	−0.0297*	−0.0419*	−0.0298*	−0.0089	−0.0132	−0.0084	−0.0130
	(−1.82)	(−1.95)	(−1.82)	(−1.95)	(−0.38)	(−0.83)	(−0.36)	(−0.82)
Time	Y	Y	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y	Y	Y
_cons	−0.5250**	−0.2015	−0.5282**	−0.2010	−0.4964**	−0.1334	−0.5203**	−0.1441
	(−2.29)	(−1.33)	(−2.31)	(−1.32)	(−2.18)	(−0.87)	(−2.28)	(−0.94)
N	6730	6730	6730	6730	6892	6892	6892	6892
R^2	0.0605	0.0612	0.0605	0.0612	0.0505	0.0527	0.0508	0.0528

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level and ***means significant at the 1% confidence level.
Source: Calculated by the authors.

shareholding ratio of the largest shareholder is used to measure the shareholding situation of large shareholders, and the sample is divided into 'less tunnelling effect' group and 'more tunnelling effect' group. The empirical results in Table 6 show that the influence of independent director network on stock price crash risk is more reflected in the 'more tunnelling effect' group. The tunnelling behaviour by large shareholders increases the firm's second-type agency costs, making the independent director network plays a greater role, thus curbing crash risk.

6.2. Internal governance perspective

In firms with low corporate governance efficiency, due to the lack of effective supervision mechanisms, the self-interested behaviour of management and the tunnelling behaviour of large shareholders will generate more agency costs, with the crash risk also increased. And good corporate governance can effectively alleviate the principal–agent problem of enterprises and restrain the occurrence of stock price crashes to a

Table 7. Internal governance perspective: corporate governance efficiency.

	Low corporate governance efficiency				High corporate governance efficiency			
Variable	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$
$CENMEAN_t$	−0.0087***	−0.0046***			0.0143	0.0008		
	(−3.35)	(−2.63)			(1.41)	(0.12)		
$CENMAX_t$			−0.0087***	−0.0040**			0.0055	−0.0062
			(−3.33)	(−2.31)			(0.53)	(−0.89)
$NCSKEW_t$	0.0908***	0.0598***	0.0909***	0.0600***	0.0450	0.0521**	0.0458	0.0510**
	(9.86)	(9.76)	(9.88)	(9.78)	(1.24)	(2.17)	(1.26)	(2.12)
RET_t	14.5017***	9.4560***	14.5305***	9.4744***	14.2712***	9.9163***	14.5163***	9.9811***
	(11.74)	(11.48)	(11.76)	(11.51)	(3.23)	(3.39)	(3.28)	(3.42)
$SIGMA_t$	−0.1322	−0.3107	−0.1377	−0.3153	−0.5185	−0.2217	−0.6772	−0.3406
	(−0.28)	(−0.97)	(−0.29)	(−0.99)	(−0.27)	(−0.18)	(−0.36)	(−0.27)
$TURNOVER_t$	−0.0633**	−0.0465**	−0.0631**	−0.0464**	−0.0488	−0.0227	−0.0487	−0.0217
	(−2.15)	(−2.37)	(−2.14)	(−2.36)	(−0.48)	(−0.34)	(−0.48)	(−0.32)
$EXEHOLD_t$	0.1157	0.0253	0.1162	0.0258	−0.0072	−0.0431	−0.0088	−0.0413
	(1.36)	(0.44)	(1.36)	(0.45)	(−0.05)	(−0.41)	(−0.06)	(−0.39)
ROA_t	0.1463	0.0729	0.1434	0.0706	0.3419	0.2475	0.3616	0.2524
	(1.07)	(0.80)	(1.05)	(0.77)	(0.78)	(0.84)	(0.82)	(0.86)
LEV_t	0.0370	0.0348	0.0361	0.0343	−0.0338	−0.0755	−0.0198	−0.0659
	(0.93)	(1.32)	(0.91)	(1.30)	(−0.21)	(−0.69)	(−0.12)	(−0.60)
MB_t	0.0009***	0.0004**	0.0009***	0.0004**	0.0019	0.0025	0.0017	0.0024
	(2.96)	(2.21)	(2.96)	(2.22)	(0.28)	(0.55)	(0.25)	(0.54)
$SIZE_t$	0.0059	−0.0036	0.0059	−0.0038	0.0626*	0.0272	0.0610	0.0274
	(0.83)	(−0.76)	(0.82)	(−0.80)	(1.68)	(1.08)	(1.63)	(1.09)
$BOARD_t$	−0.0047	−0.0045	−0.0042	−0.0043	0.0060	−0.0006	0.0066	0.0009
	(−1.13)	(−1.62)	(−1.01)	(−1.56)	(0.32)	(−0.05)	(0.35)	(0.08)
OUT_t	0.0636	0.0462	0.0852	0.0566	−0.4377	−0.2583	−0.4389	−0.2368
	(0.48)	(0.52)	(0.64)	(0.64)	(−0.83)	(−0.73)	(−0.83)	(−0.67)
DUALITYt	−0.0323*	−0.0242**	−0.0322*	−0.0241**	0.0121	−0.0049	0.0116	−0.0073
	(−1.85)	(−2.07)	(−1.84)	(−2.07)	(0.23)	(−0.14)	(0.22)	(−0.21)
Time	Y	Y	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y	Y	Y
_cons	−0.4254***	−0.1047	−0.4347***	−0.1061	−1.4503*	−0.5993	−1.3877	−0.5995
	(−2.58)	(−0.95)	(−2.63)	(−0.96)	(−1.69)	(−1.05)	(−1.62)	(−1.05)
N	12,517	12,517	12,517	12,517	838	838	838	838
R^2	0.0520	0.0526	0.0520	0.0525	0.0775	0.0822	0.0755	0.0830

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level and ***means significant at the 1% confidence level.
Source: Calculated by the authors.

certain extent. Hence, this article argues that independent director networks can play a greater role in firms with less efficient governance. Following Cheng et al. (2019), the proportion of independent directors, senior management's shareholding and the nature of property rights are used as the basis for measuring the efficiency of corporate governance. When the enterprise belongs to non-state-owned enterprise, the proportion of independent directors is higher than the median of the same industry, and the proportion of senior executives' shareholding is higher than the median of the same industry in the same year, it is regarded as an enterprise with high corporate governance efficiency. Otherwise, it is regarded as an enterprise with low governance efficiency. The empirical results in Table 7 show that the influence of independent director network on stock price crash risk is more obvious in firms with lower corporate governance efficiency, while the relationship is not significant in firms with higher governance efficiency, which further confirms that independent director network acts on stock price crash risk through the influence of agency cost.

Table 8. External supervision perspective: analyst attention.

	Low analyst attention				High analyst attention			
Variable	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$
$CENMEAN_t$	−0.0098***	−0.0064***			−0.0004	0.0013		
	(−3.05)	(−3.05)			(−0.09)	(0.46)		
$CENMAX_t$			−0.0110***	−0.0064***			−0.0003	0.0012
			(−3.38)	(−3.04)			(−0.07)	(0.45)
$NCSKEW_t$	0.0873***	0.0530***	0.0873***	0.0530***	0.0325**	0.0471***	0.0326**	0.0470***
	(7.82)	(7.32)	(7.81)	(7.32)	(2.21)	(4.45)	(2.22)	(4.45)
RET_t	14.3292***	8.7021***	14.3280***	8.7099***	9.4422***	6.9443***	9.4450***	6.9371***
	(8.57)	(8.04)	(8.57)	(8.04)	(5.64)	(5.76)	(5.64)	(5.75)
$SIGMA_t$	−0.2444	−0.4657	−0.2385	−0.4623	0.4195	−0.0108	0.4175	−0.0062
	(−0.41)	(−1.22)	(−0.40)	(−1.21)	(0.57)	(−0.02)	(0.56)	(−0.01)
$TURNOVER_t$	−0.0637*	−0.0396*	−0.0631*	−0.0393*	−0.0421	−0.0347	−0.0421	−0.0347
	(−1.83)	(−1.75)	(−1.81)	(−1.74)	(−0.87)	(−1.00)	(−0.87)	(−1.00)
$EXEHOLD_t$	−0.0033	−0.0344	−0.0032	−0.0343	0.1806**	0.0567	0.1806**	0.0565
	(−0.04)	(−0.59)	(−0.04)	(−0.59)	(2.04)	(0.93)	(2.04)	(0.93)
ROA_t	−0.2126	−0.1125	−0.2174	−0.1161	0.4867**	0.2943*	0.4865**	0.2945*
	(−1.27)	(−1.04)	(−1.30)	(−1.07)	(2.05)	(1.75)	(2.05)	(1.76)
LEV_t	0.1117**	0.0739**	0.1105**	0.0730**	0.0402	0.0531	0.0402	0.0531
	(2.40)	(2.45)	(2.37)	(2.42)	(0.56)	(1.06)	(0.56)	(1.06)
MB_t	0.0008**	0.0004*	0.0008**	0.0004*	0.0252***	0.0213***	0.0252***	0.0213***
	(2.43)	(1.84)	(2.43)	(1.84)	(3.46)	(4.15)	(3.46)	(4.15)
$SIZE_t$	−0.0294***	−0.0219***	−0.0289***	−0.0218***	0.0132	0.0041	0.0131	0.0041
	(−2.70)	(−3.10)	(−2.65)	(−3.09)	(1.21)	(0.54)	(1.21)	(0.55)
$BOARD_t$	−0.0098*	−0.0070**	−0.0088	−0.0066*	−0.0001	−0.0016	−0.0001	−0.0017
	(−1.79)	(−1.98)	(−1.61)	(−1.85)	(−0.01)	(−0.40)	(−0.01)	(−0.40)
OUT_t	0.0891	0.0890	0.1170	0.1057	−0.1105	−0.0849	−0.1099	−0.0875
	(0.52)	(0.80)	(0.69)	(0.96)	(−0.60)	(−0.67)	(−0.60)	(−0.69)
DUALITYt	−0.0284	−0.0210	−0.0281	−0.0208	−0.0399	−0.0330*	−0.0400	−0.0329*
	(−1.32)	(−1.50)	(−1.30)	(−1.49)	(−1.60)	(−1.89)	(−1.61)	(−1.89)
Time	Y	Y	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y	Y	Y
_cons	0.3914	0.3105*	0.3661	0.2998*	−0.7085***	−0.3627**	−0.7081***	−0.3625**
	(1.59)	(1.94)	(1.48)	(1.87)	(−2.77)	(−2.05)	(−2.77)	(−2.04)
N	9047	9047	9047	9047	4575	4575	4575	4575
R^2	0.0537	0.0566	0.0539	0.0566	0.0730	0.0769	0.0730	0.0769

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level, and ***means significant at the 1% confidence level.
Source: Calculated by the authors.

6.3. External supervision perspective

Strong external supervision increases the firm's cost of hiding negative news, which can effectively restrain the self-interested behaviour of management and the tunnelling behaviour of large shareholders, and reduce the crash risk. For firms with insufficient external supervision, the principal–agent problem is more prominent with higher crash risk, and the influence of independent director network on crash risk will be more obvious. Following Kim and Zhang (2014), we employ analyst attention and research report attention to measure the external supervision of the firm. The higher the degree of analyst attention and research reports, the higher the degree of external supervision. Based on the annual median of the above indicators, the results of heterogeneity regression are shown in Tables 8 and 9. It can be seen that the influence of network position of independent directors on stock price crash risk is significantly negative in firms with a low degree of external supervision. While in firms with a high degree of external supervision, the relationship between the network of

Table 9. External supervision perspective: research report attention.

	Low research report attention				High research report attention			
Variable	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$	$NCSKW_{t+1}$	$DUVOL_{t+1}$
$CENMEAN_t$	−0.0087***	−0.0055***			−0.0020	−0.0001		
	(−2.77)	(−2.70)			(−0.51)	(−0.05)		
$CENMAX_t$			−0.0097***	−0.0056***			−0.0023	−0.0001
			(−3.06)	(−2.71)			(−0.57)	(−0.05)
$NCSKEW_t$	0.0876***	0.0548***	0.0876***	0.0549***	0.0265*	0.0446***	0.0266*	0.0446***
	(8.04)	(7.76)	(8.04)	(7.77)	(1.73)	(4.00)	(1.74)	(4.00)
RET_t	14.7551***	8.9638***	14.7543***	8.9693***	8.0932***	6.1229***	8.1055***	6.1237***
	(9.14)	(8.56)	(9.14)	(8.56)	(4.72)	(4.89)	(4.72)	(4.89)
$SIGMA_t$	−0.1861	−0.4031	−0.1818	−0.4005	0.1193	−0.1483	0.1139	−0.1486
	(−0.32)	(−1.08)	(−0.32)	(−1.07)	(0.16)	(−0.27)	(0.15)	(−0.27)
$TURNOVER_t$	−0.0640*	−0.0408*	−0.0634*	−0.0405*	−0.0290	−0.0229	−0.0291	−0.0229
	(−1.87)	(−1.84)	(−1.86)	(−1.83)	(−0.58)	(−0.63)	(−0.58)	(−0.63)
$EXEHOLD_t$	0.0151	−0.0343	0.0154	−0.0343	0.1682*	0.0556	0.1684*	0.0556
	(0.18)	(−0.61)	(0.18)	(−0.61)	(1.85)	(0.90)	(1.86)	(0.90)
ROA_t	−0.1740	−0.1002	−0.1781	−0.1033	0.2407	0.1573	0.2408	0.1573
	(−1.06)	(−0.94)	(−1.09)	(−0.97)	(0.98)	(0.90)	(0.98)	(0.90)
LEV_t	0.1069**	0.0720**	0.1058**	0.0713**	0.0339	0.0531	0.0341	0.0532
	(2.34)	(2.43)	(2.32)	(2.41)	(0.45)	(1.02)	(0.46)	(1.02)
MB_t	0.0008**	0.0004*	0.0008**	0.0004*	0.0315***	0.0262***	0.0315***	0.0262***
	(2.49)	(1.87)	(2.49)	(1.88)	(4.20)	(4.95)	(4.20)	(4.95)
$SIZE_t$	−0.0254**	−0.0200***	−0.0251**	−0.0200***	0.0080	0.0008	0.0080	0.0008
	(−2.44)	(−2.97)	(−2.41)	(−2.96)	(0.72)	(0.10)	(0.72)	(0.10)
$BOARD_t$	−0.0085	−0.0061*	−0.0077	−0.0057	−0.0006	−0.0024	−0.0005	−0.0024
	(−1.61)	(−1.77)	(−1.45)	(−1.64)	(−0.10)	(−0.57)	(−0.08)	(−0.57)
OUT_t	0.0170	0.0366	0.0419	0.0512	0.0528	0.0159	0.0577	0.0162
	(0.10)	(0.34)	(0.25)	(0.48)	(0.28)	(0.12)	(0.31)	(0.13)
DUALITYt	−0.0319	−0.0215	−0.0317	−0.0214	−0.0384	−0.0356**	−0.0386	−0.0357**
	(−1.52)	(−1.58)	(−1.51)	(−1.57)	(−1.51)	(−2.01)	(−1.52)	(−2.01)
Time	Y	Y	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y	Y	Y
_cons	0.3086	0.2735*	0.2877	0.2644*	−0.6033**	−0.3022*	−0.6052**	−0.3023*
	(1.31)	(1.79)	(1.22)	(1.73)	(−2.29)	(−1.67)	(−2.30)	(−1.67)
N	9532	9532	9532	9532	4090	4090	4090	4090
R^2	0.0532	0.0572	0.0534	0.0572	0.0735	0.0776	0.0735	0.0776

Note: *means significant at the 10% confidence level, **means significant at the 5% confidence level and ***means significant at the 1% confidence level.
Source: Calculated by the authors.

independent directors and stock price crash risk is not significant. The results also confirm the mechanism by which the independent director network affects the stock price crash risk.

7. Conclusion

This article examines the impact of independent director network on stock price crash risk and the roles of two types of agency costs. The empirical results show that the higher the network centrality of independent directors, the lower the crash risk of stock price. The agency cost constituted by the principal–agent cost and the large shareholder's tunnelling behaviour plays significant intermediary roles in independent director network affecting the crash risk. Further research shows that the influence of independent director network on stock price crash risk is particularly obvious in firms with unreasonable ownership structure, poor internal governance and weak external supervision. This further confirms that the independent director network can reduce the risk of stock price collapse by reducing the two types of agency costs. In addition, it shows that reasonable shareholding structure and internal governance mechanism can help alleviate the principal–agent problem and reduce the crash risk of stock price. Enterprises should pay attention to the evaluation of the company by analysts and research reports, and give full play to the role of external supervision.

The conclusions of this study have important implications. From the perspective of social network, independent directors are not 'vases', and their governance behaviours will vary according to the importance of the network. Those independent directors with network importance can play a better role in corporate governance. In addition, in the market with weak investor protection, strengthening the construction of the independent director system, especially guiding independent directors to improve their social network status through various effective channels is of great importance for preventing the risk of stock price collapse of listed companies, which helps protecting the rights and interests of investors. For listed companies, hiring independent directors with strong social capital contributes to reducing firm agency costs. Regulatory authorities and listed companies should take appropriate incentive measures to actively guide independent directors to improve their social network status through various effective means, so as to prevent the crash risk of stock price, and to maintain the smooth operation of the capital market.

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References

Ang, J. S., Cole, R. A., & Lin, J. W. (2000). Agency costs and ownership structure. *The Journal of Finance*, *55*(1), 81–106. https://doi.org/10.1111/0022-1082.00201

Ararat, M., & Yurtoglu, B. B. (2021). Female directors, board committees, and firm performance: time-series evidence from Turkey. *Emerging Markets Review*, *48*, 100768. https://doi.org/10.1016/j.ememar.2020.100768

Berkman, H., Koch, P., & Westerholm, P. J. (2020). Inside the director network: When directors trade or hold inside, interlock, and unconnected stocks. *Journal of Banking & Finance*, *118*, 105892. https://doi.org/10.1016/j.jbankfin.2020.105892

Cao, J., Wen, F., Zhang, Y., Yin, Z., & Zhang, Y. (2022). Idiosyncratic volatility and stock price crash risk: Evidence from china. *Finance Research Letters*, *44*, 102095. https://doi.org/10.1016/j.frl.2021.102095

Cao, P., Qin, L., & Zhu, H. (2019). Local corruption and stock price crash risk: Evidence from China. *International Review of Economics & Finance*, *63*, 240–252. https://doi.org/10.1016/j.iref.2018.11.006

Cheng, L. Y., Su, Y. C., Yan, Z., & Zhao, Y. (2019). Corporate governance and target price accuracy. *International Review of Financial Analysis*, *64*, 93–101. https://doi.org/10.1016/j.irfa.2019.05.005

Fracassi, C., & Tate, G. (2012). External networking and internal firm governance. *The Journal of Finance*, *67*(1), 153–194. https://doi.org/10.1111/j.1540-6261.2011.01706.x
Gong, M., Wang, Y., & Yang, X. (2021). Do independent directors restrain controlling shareholders' tunneling? Evidence from a natural experiment in China. *Economic Modelling*, *94*, 548–559. https://doi.org/10.1016/j.econmod.2020.01.023
Guo, C., & Lv, P. (2018). Network position of independent director in cross-border mergers and acquisitions. *International Journal of Emerging Markets*, *13*(1), 118–135. https://doi.org/10.1108/IJoEM-01-2017-0027
Jackson, M. O., Rogers, B. W., & Zenou, Y. (2017). The economic consequences of social-network structure. *Journal of Economic Literature*, *55*(1), 49–95. https://doi.org/10.1257/jel.20150694
Jiang, F., Cai, W., Wang, X., & Zhu, B. (2018). Multiple large shareholders and corporate investment: Evidence from China. *Journal of Corporate Finance*, *50*, 66–83. https://doi.org/10.1016/j.jcorpfin.2018.02.001
Jiang, G., Lee, C. M., & Yue, H. (2010). Tunneling through intercorporate loans: The China experience. *Journal of Financial Economics*, *98*(1), 1–20. https://doi.org/10.1016/j.jfineco.2010.05.002
Jiang, G., Rao, P., & Yue, H. (2015). Tunneling through non-operational fund occupancy: An investigation based on officially identified activities. *Journal of Corporate Finance*, *32*, 295–311. https://doi.org/10.1016/j.jcorpfin.2014.10.011
Jin, H. M., Su, Z. Q., Wang, L., & Xiao, Z. (2022). Do academic independent directors matter? Evidence from stock price crash risk. *Journal of Business Research*, *144*, 1129–1148. https://doi.org/10.1016/j.jbusres.2022.02.054
Jin, L., & Myers, S. C. (2006). R2 around the world: New theory and new tests. *Journal of Financial Economics*, *79*(2), 257–292. https://doi.org/10.1016/j.jfineco.2004.11.003
Kang, Q., & Liu, Q. (2010). Information-based stock trading, executive incentives, and the principal-agent problem. *Management Science*, *56*(4), 682–698. https://doi.org/10.1287/mnsc.1090.1128
Kim, J. B., Li, Y., & Zhang, L. (2011a). Corporate tax avoidance and stock price crash risk: Firm-level analysis. *Journal of Financial Economics*, *100*(3), 639–662. https://doi.org/10.1016/j.jfineco.2010.07.007
Kim, J. B., Li, Y., & Zhang, L. (2011b). CFOs versus CEOs: Equity incentives and crashes. *Journal of Financial Economics*, *101*(3), 713–730. https://doi.org/10.1016/j.jfineco.2011.03.013
Kim, J. B., & Zhang, L. (2014). Financial reporting opacity and expected crash risk: Evidence from implied volatility smirks. *Contemporary Accounting Research*, *31*(3), 851–875. https://doi.org/10.1111/1911-3846.12048
Kuang, Y. F., & Lee, G. (2017). Corporate fraud and external social connectedness of independent directors. *Journal of Corporate Finance*, *45*, 401–427. https://doi.org/10.1016/j.jcorpfin.2017.05.014
Larcker, D. F., So, E. C., & Wang, C. C. (2010). *Boardroom centrality and stock returns*. Graduate School of Business.
Li, Q., & Guo, M. (2021). Local economic performance, political promotion, and stock price crash risk: Evidence from China. *Emerging Markets Finance and Trade*, *57*(15), 4330–4349. https://doi.org/10.1080/1540496X.2020.1809373
Liao, F. N., & Chen, F. W. (2021). Independent director interlocks: Effects and boundary on the earnings persistence of the firm. *Economic Research-Ekonomska Istraživanja*, *34*(1), 383–409. https://doi.org/10.1080/1331677X.2020.1788965
Luo, Y., & Zhang, C. (2020). Economic policy uncertainty and stock price crash risk. *Research in International Business and Finance*, *51*, 101112. https://doi.org/10.1016/j.ribaf.2019.101112
Masulis, R. W., & Mobbs, S. (2014). Independent director incentives: Where do talented directors spend their limited time and energy? *Journal of Financial Economics*, *111*(2), 406–429. https://doi.org/10.1016/j.jfineco.2013.10.011
Nguyen, B. D., & Nielsen, K. M. (2010). The value of independent directors: Evidence from sudden deaths. *Journal of Financial Economics*, *98*(3), 550–567. https://doi.org/10.1016/j.jfineco.2010.07.004

Pang, J., Zhang, X., & Zhou, X. (2020). From classroom to boardroom: The value of academic independent directors in China. *Pacific-Basin Finance Journal*, *62*, 101319. https://doi.org/10.1016/j.pacfin.2020.101319

Shaw, T. S., Cordeiro, J. J., & Saravanan, P. (2016). Director network resources and firm performance: Evidence from Indian corporate governance reforms. *Asian Business & Management*, *15*(3), 165–200. https://doi.org/10.1057/s41291-016-0003-1

Sila, V., Gonzalez, A., & Hagendorff, J. (2017). Independent director reputation incentives and stock price informativeness. *Journal of Corporate Finance*, *47*, 219–235. https://doi.org/10.1016/j.jcorpfin.2017.09.018

Sun, J., Yuan, R., Cao, F., & Wang, B. (2017). Principal–principal agency problems and stock price crash risk: Evidence from the split–share structure reform in China. *Corporate Governance: An International Review*, *25*(3), 186–199. https://doi.org/10.1111/corg.12202

Usman, M., Farooq, M. U., Zhang, J., Makki, M. A. M., & Khan, M. K. (2019). Female directors and the cost of debt: Does gender diversity in the boardroom matter to lenders? *Managerial Auditing Journal*, *34*(4), 374–392. https://doi.org/10.1016/j.econlet.2018.01.030

Wang, Z., Xie, Z., & Chen, C. (2022). Executives with economic management education backgrounds and stock price crash risk: Evidence from Chinese A-share markets. *Emerging Markets Finance and Trade*, *58*(10), 2764–2782. https://doi.org/10.1080/1540496X.2021.2009798

Wu, Y., & Dong, B. (2021). The value of independent directors: Evidence from China. *Emerging Markets Review*, *49*, 100763. https://doi.org/10.1016/j.ememar.2020.100763

Xu, N., Li, X., Yuan, Q., & Chan, K. C. (2014). Excess perks and stock price crash risk: Evidence from China. *Journal of Corporate Finance*, *25*, 419–434. https://doi.org/10.1016/j.jcorpfin.2014.01.006

Yang, C., Chen, X., & Chen, X. (2021). Vertical interlock and stock price crash risk. *Pacific-Basin Finance Journal*, *68*, 101387. https://doi.org/10.1016/j.pacfin.2020.101387

Zhang, K., & Truong, C. (2019). What's the value of politically connected directors? *Journal of Contemporary Accounting & Economics*, *15*(3), 100161. https://doi.org/10.1016/j.jcae.2019.100161